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ISSN 0417-9927

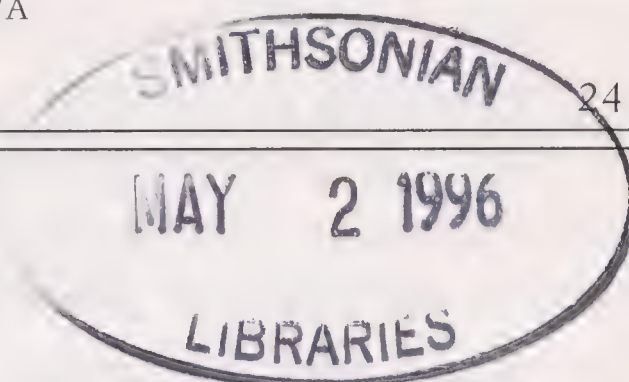
D O R I A N A

Supplemento agli

ANNALI DEL MUSEO CIVICO DI STORIA NATURALE "G. DORIA"

GENOVA

Vol. VI - N. 289



24-I-1995

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SEXING MUSEUM SPECIMENS OF SLENDER-BILLED CURLEW *NUMENIUS TENUIROSTRIS* BY DISCRIMINANT ANALYSIS

(AVES: SCOLOPACIDAE)

INTRODUCTION. The Slender-billed Curlew *Numenius tenuirostris* (Aves: Scolopacidae) is one of the most threatened with extinction species of the western Palearctic and, at the same time, one of the most poorly known (GRETTON, 1991). An exhaustive review of all Italian Slender-billed Curlew records showed that specimens collected in Italy, with a total of at least 100 birds still preserved in museums or private collections, probably represent the largest regional sample of this species (BACCETTI, in press).

Slender-billed Curlews are sexually monomorphic with respect to plumage characters (cf. CRAMP & SIMMONS, 1983) and sex identification is not possible even when examining birds in the hand. Discriminant analysis has been successfully applied in a wide variety of cases in the past, in order to obtain a linear combination of measurements for determining the sex in birds, when sexes are morphometrically different but measurements have partially overlapping distributions (e. g. SKEEL, 1982; SUMMERS *et al.*, 1988; WOOD, 1987).

The present rarity of the Slender-billed Curlew does not allow any longer biometrics and population structure to be studied in the field. Preserved material, therefore, has a unique importance as a

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source of information. Current conservation programs, moreover, may require in the near future safe sexing methods for the surviving birds.

METHODS. Skins of 82 Slender-billed Curlews were examined and measured. All the birds were collected during the last two centuries in Italy and showed a relatively even distribution between September and May with a single peak of presence in March (51% of 55 specimens with known month of capture). Different age classes were not considered in the analysis, mainly because age could be assessed only for a few specimens. However, wing and bill lengths seem not to statistically differ between juveniles and adults of the same sex from about October (CRAMP & SIMMONS, 1983). 67 specimens belong to Italian museums or collections, namely Museo Civico di Zoologia, Roma (15), Museo La Specola, Firenze (13), Museo Regionale di Storia Naturale, Torino (8), Museo di Storia Naturale, Milano (6), Accademia dei Fisiocritici, Siena (4), Museo Civico di Storia Naturale G. Doria, Genova (4), Museo Friulano di Storia Naturale, Udine (4), Museo Ornitologico Brandolini, Ravenna (3), Museo dell'Istituto Nazionale per la Fauna Selvatica, Ozzano Emilia, BO (3), Museo Ornitologico F. Foschi, Forlì (3), Collezione Beni, Comune di Stia, AR (2), Collezione Fantin, Treviso (2), Collezione Bani, Comune di Borgo San Lorenzo, FI (1), Collezione Fiori, Scuola Media di Sassuolo, MO (1), Museo Civico di Storia Naturale, Brescia (1), Museo di Storia Naturale del Salento, Calimera, LE (1). 11 additional sets of measurements of Italian birds were obtained abroad: National Museum of Natural History, Leiden, The Netherlands (4), American Museum of Natural History, New York, USA (3), Zoologisch Museum, Amsterdam, The Netherlands (2), Cambridge Museum, USA (1), Zoologisches Forschungsinstitut und Museum A. Koenig, Bonn, Germany (1).

Two measurements were taken on all the specimens: wing length, from the carpal joint to the tip of the longest primary feather (maximum chord) and culmen length, from the tip of the bill to feathering. Wing length was measured to the nearest 1 mm, culmen length to the 0.1 mm (PRATER *et al.*, 1977). No corrections for measurement variations due to specimens' shrinkage were adopted.

Sex determination by dissection was available for 61 individuals. This sample consisted of 39 males and 22 females and it was used as reference group for discriminant analysis.

Data was analysed using standard discriminant analysis procedures

of the program SPSS/PC+, Version 4.0. Calculations of probability contours were obtained using the formula proposed by GREEN & THEOBALD (1989).

RESULTS. The following discriminant function was produced:

$$D = 0.0751W + 0.1672B - 32.3424$$

where D = discriminant score, W = wing length and B = bill length. Group centroids (mean discriminant scores) for females and males were D = +1.9816 and D = -1.1179, respectively. Measurements of the reference group are given in Table I. Using the criterion level of p = 0.95, 51 birds (83.6%) were correctly sexed, 3 (4.9%) were incorrectly classified and 7 (11.5%) resulted of unknown sex. The discriminant weight of culmen length was considerably higher than that wing length,

TABLE I
MEASUREMENTS OF 61 ITALIAN SLENDER-BILLED CURLEWS
NUMENIUS TENUIROSTRIS (SEXED BY DISSECTION AND USED AS
REFERENCE GROUP) AND TOTAL COVARIANCE MATRIX

	Males				Females			
	Mean	S.D.	Range	N	Mean	S.D.	Range	N
Wing	248.0	6.0	237.0-260.0	39	260.1	4.9	249.0-270.0	22
Culmen	75.3	5.3	66.8-92.6	39	88.4	2.9	83.0-94.5	22

	Wing	Culmen
Wing	65.42	45.78
Culmen	45.78	61.61

being standardized canonical discriminant function coefficients 0.7722 and 0.4247, respectively. Figure 1 shows measurements of the reference birds with the lines of the discriminant function for an a posteriori probability of 0.05, 0.5 and 0.95 of being of a particular sex. Critical discriminant scores at 0.05, 0.5 and 0.95 level were -0.4844, +0.4473 and +1.3794.

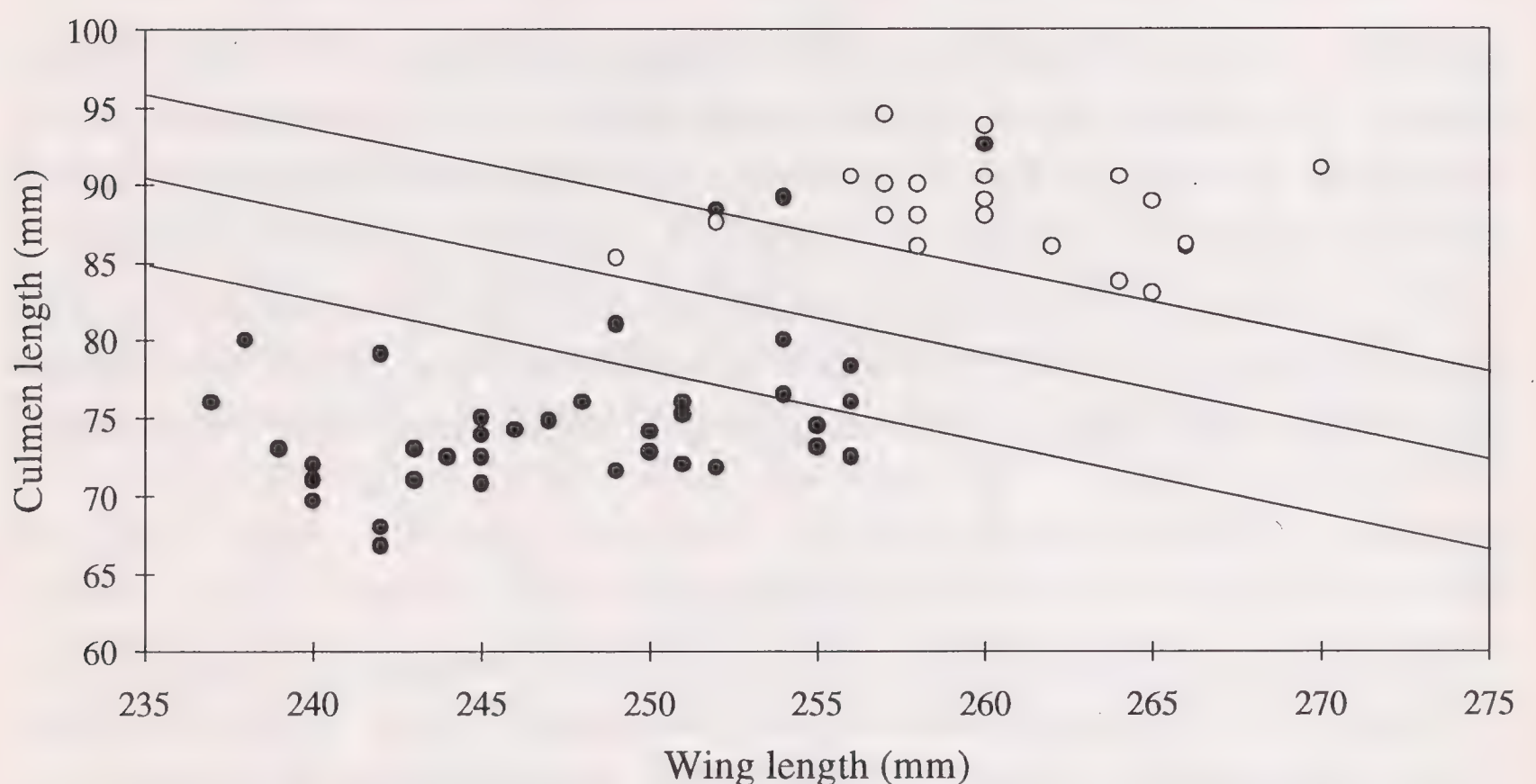


Fig. 1 Size segregation of males (solid dots) and females (open dots) Slender-billed Curlews *Numenius tenuirostris*, with probability contours at 0.05, 0.5 and 0.95 levels of being of a particular sex (reference group of 61 specimens).

Performing univariate analysis, i.e. considering the two measurements separately, culmen length correctly reassigned 48 (78.7%) birds, misclassified 3 (4.9%) and undetermined 10 (16.4%), wing length 17 (27.9%), 9 (14.7%) and 35 (57.4%).

Using the discriminant function for sexing the 21 specimens that had not been sexed at dissection, 13 resulted males, 7 females and 1 could not be sexed, as it did not exceed the 0.95 probability level of being of a particular sex. Table II shows the measurements for the sample of 81 sexed birds. Although males largely outnumbered females, the sex ratio in the overall sample (52 males and 29 females) did not significantly differ from a ratio of 1:1 (chi-squared = 1.7931, df = 1, $p > 0.09$).

TABLE II
MEASUREMENTS OF 81 ITALIAN SLENDER-BILLED CURLEWS
NUMENIUS TENUIROSTRIS (20 SEXED BY DISCRIMINANT ANALYSIS)

	Males				Females			
	Mean	S.D.	Range	N	Mean	S.D.	Range	N
Wing	247.4	6.0	230.0-260.0	52	259.3	5.1	246.0-270.0	29
Culmen	74.7	5.1	66.0-92.6	52	89.0	3.8	83.0-101.3	29

ACKNOWLEDGMENTS

I wish to thank all the people who helped me in gathering measurements of the birds and/or provided useful information: N. Baccetti, F. Barbagli, R. Basso, C. Bertarelli, E. Borgo, G. Cherubini, M. Della Toffola, R. Dekker, M. Engelmoer, G. Fantin, U. F. Foschi, A. Gretton, G. Keijl, G. Marzano, A. Nistri, A. Ortali, R. Parodi, T. G. Prins, F. Spina, G. Tellini, R. van der Elzen, C. Voisin. I am also indebted to the directors and keepers of all the museums and collections listed under Methods, who allowed specimen examination.

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ABSTRACT

Discriminant analysis for sex determination in the Slender-billed Curlew, *Numenius tenuirostris*, based on wing and bill lengths taken in 61 specimens sexed by dissection was performed. The calculated discriminant function allowed to sex 20 more specimens. All the examined specimens had been collected in Italy.

RIASSUNTO

Vengono esposti i risultati di una analisi discriminante per la determinazione del sesso nel Chiurlotello, *Numenius tenuirostris*, in base alle misure di ala e becco di 61 pelli di esemplari sessati per dissezione e raccolti in Italia. La funzione ottenuta ha permesso la determinazione a posteriori del sesso di altre 20 pelli di origine italiana. Si forniscono le misure di ala e becco per il campione usato come gruppo di riferimento e per quello ottenuto aggiungendo al precedente i 20 esemplari sessati in base all'analisi discriminante.